

CLAIMS

1. A method of fabricating an integrated optical device, said method comprising:

providing a support wafer defining an electrode support surface;

forming an electrode pattern over said electrode support surface of said support wafer;

5 forming a non-polymeric buffer layer on at least a portion of said electrode pattern and over at least a portion of said support wafer;

forming a waveguide core material layer over said non-polymeric buffer layer;

removing portions of said core material layer to define a waveguide core; and

10 positioning a cladding material in optical communication with said waveguide core such that said buffer layer, said cladding material, and said waveguide core define an optically-clad waveguide core, wherein at least one of said cladding material and said waveguide core are configured such that a control signal applied to said electrode pattern alters a transmission characteristic of an optical signal propagating along said waveguide core.

15 2. A method of fabricating an integrated optical device as claimed in claim 1 wherein said electrode pattern, said buffer layer, and said waveguide core are formed such that said electrode pattern is embedded in said device beneath said waveguide core.

20 3. A method of fabricating an integrated optical device as claimed in claim 1 wherein said electrode pattern is formed so as to define at least two electrically isolated control electrodes over said electrode support surface.

25 4. A method of fabricating an integrated optical device as claimed in claim 3 wherein a sufficient portion of said buffer layer formed over said electrode pattern is maintained prior to positioning said cladding material in optical communication with said waveguide core so as to form an electrically insulative barrier between said isolated control electrodes.

5. A method of fabricating an integrated optical device as claimed in claim 3 wherein an electrically insulative barrier layer is formed over said control electrodes prior to positioning said cladding material in optical communication with said waveguide core.

5 6. A method of fabricating an integrated optical device as claimed in claim 3 wherein said electrode pattern is formed such that said control electrodes are substantially co-planar.

7. A method of fabricating an integrated optical device as claimed in claim 1 wherein said electrode pattern defines at least two electrically isolated control electrodes and said waveguide
10 core is formed through a process by which said position of said core in a plane offset from and generally parallel to a plane occupied by said control electrodes is controlled relative to respective positions of said control electrodes in said control electrode plane.

8. A method of fabricating an integrated optical device as claimed in claim 1 further comprising
15 the step of positioning an additional electrode pattern above said electrode pattern formed over said electrode support surface of said support wafer.

9. A method of fabricating an integrated optical device as claimed in claim 8 wherein said additional electrode pattern comprises a single control electrode substantially aligned with said
20 waveguide core.

10. A method of fabricating an integrated optical device as claimed in claim 8 wherein said additional electrode pattern comprises a single control electrode offset along one side of said waveguide core and said electrode pattern formed over said electrode support surface of said
25 support wafer comprises a single control electrode offset along an opposite side of said waveguide core.

11. A method of fabricating an integrated optical device as claimed in claim 10 wherein said single control electrode offset along one side of said waveguide core defines a thickness sufficient to extend alongside a substantial portion of said waveguide core.

5 12. A method of fabricating an integrated optical device as claimed in claim 10 wherein said additional electrode pattern comprises an additional single control electrode offset along said opposite side of said waveguide core above said electrode pattern formed over said electrode support surface of said support wafer.

10 13. A method of fabricating an integrated optical device as claimed in claim 8 wherein:
said additional electrode pattern comprises a single control electrode offset along one side of said waveguide core and an additional single control electrode offset along an opposite side of said waveguide core; and
said electrode pattern formed over said electrode support surface of said support wafer
15 comprises a single control electrode substantially aligned with said waveguide core.

14. A method of fabricating an integrated optical device as claimed in claim 1 wherein said electrode pattern comprises at least one material selected from Au, Pt, Cr, Ta, Ti, indium tin oxide, and combinations thereof.

20 15. A method of fabricating an integrated optical device as claimed in claim 1 wherein said electrode pattern comprises Cr.

25 16. A method of fabricating an integrated optical device as claimed in claim 1 wherein said electrode pattern comprises a conductive material characterized by a melting point of at least about 1500°C.

17. A method of fabricating an integrated optical device as claimed in claim 1 wherein said electrode pattern comprises first and second conductive layers, said first conductive layer having

relatively enhanced adhesive properties and said second conductive layer having relatively enhanced conductive properties.

18. A method of fabricating an integrated optical device as claimed in claim 1 wherein said
5 buffer layer is formed on said electrode pattern and said support wafer.

19. A method of fabricating an integrated optical device as claimed in claim 1 wherein said
buffer layer is formed through a sol-gel process.

10 20. A method of fabricating an integrated optical device as claimed in claim 19 wherein said sol-
gel process is characterized by a maximum processing temperature below about 400°C.

15 21. A method of fabricating an integrated optical device as claimed in claim 1 wherein said
buffer layer is formed at a maximum processing temperature at least 500°C below a melting
point of said buffer layer.

22. A method of fabricating an integrated optical device as claimed in claim 1 wherein said
buffer layer is formed at a maximum processing temperature at least 500°C below a melting
point of said electrode pattern.

20 23. A method of fabricating an integrated optical device as claimed in claim 1 wherein said
buffer layer is formed through a plasma enhanced chemical vapor deposition process.

25 24. A method of fabricating an integrated optical device as claimed in claim 23 wherein said
plasma enhanced chemical vapor deposition process is characterized by a maximum processing
temperature below about 1000°C.

25. A method of fabricating an integrated optical device as claimed in claim 1 wherein said
buffer layer comprises a silica-based buffer layer.

26. A method of fabricating an integrated optical device as claimed in claim 1 further comprising the act of removing portions of said buffer layer while leaving a sufficient amount of said buffer layer unremoved to define a remaining protective layer over said electrode pattern.

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27. A method of fabricating an integrated optical device as claimed in claim 1 wherein said buffer layer comprises a material having a refractive index lower than a refractive index of said core material at an operating temperature and operating wavelength of said device.

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28. A method of fabricating an integrated optical device as claimed in claim 1 wherein said buffer layer comprises a material characterized by a refractive index of between about 1.440 and about 1.450 at a selected operating temperature and operating wavelength of said device.

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29. A method of fabricating an integrated optical device as claimed in claim 1 wherein said buffer layer comprises a material that is transmissive to light of at least one of the following wavelengths: about 1.3 μ m and about 1.55 μ m.

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30. A method of fabricating an integrated optical device as claimed in claim 1 wherein said buffer layer comprises an electrically insulating, non-metallic material.

31. A method of fabricating an integrated optical device as claimed in claim 1 wherein said core layer comprises a material selected from polymers, silica, doped silica, and combinations thereof.

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32. A method of fabricating an integrated optical device as claimed in claim 1 wherein said core layer is formed through a sol-gel process.

33. A method of fabricating an integrated optical device as claimed in claim 1 wherein said core layer comprises a material characterized by a refractive index of between about 1.450 and about 1.455 at a selected operating temperature and operating wavelength of said device.

34. A method of fabricating an integrated optical device as claimed in claim 1 wherein said portions of said core layer are removed through reactive ion etching.

5 35. A method of fabricating an integrated optical device as claimed in claim 1 wherein said waveguide core is formed by patterning said core material layer utilizing a waveguide mask.

36. A method of fabricating an integrated optical device as claimed in claim 1 wherein said cladding material comprises an electrooptic medium.

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37. A method of fabricating an integrated optical device as claimed in claim 36 wherein said cladding material comprises an electrooptic chromophore.

38. A method of fabricating an integrated optical device as claimed in claim 36 wherein said cladding material comprises a medium dominated by the Pockels effect.

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39. A method of fabricating an integrated optical device as claimed in claim 36 wherein said cladding material comprises a medium dominated by the Kerr effect.

20 40. A method of fabricating an integrated optical device as claimed in claim 1 wherein said cladding material is positioned in optical communication with said waveguide core through a sol-gel process.

25 41. A method of fabricating an integrated optical device as claimed in claim 1 wherein said cladding material is positioned in optical communication with said waveguide core as a polymeric solution.

42. A method of fabricating an integrated optical device as claimed in claim 1 wherein said cladding material is positioned in optical communication with said waveguide core as an aerosol of a polymeric solution.

5 43. A method of fabricating an integrated optical device as claimed in claim 1 wherein said cladding material is positioned in optical communication with said waveguide core as a vapor deposited polymer.

10 44. A method of fabricating an integrated optical device as claimed in claim 1 wherein said cladding material is positioned in optical communication with said waveguide core as an electro-deposited polymer.

15 45. A method of fabricating an integrated optical device as claimed in claim 1 wherein said cladding material is positioned in optical communication with said waveguide core while a poling voltage is applied across said electrode pattern.

20 46. A method of fabricating an integrated optical device as claimed in claim 45 wherein said poling voltage is maintained during curing, cross-linking, or thermo-setting of said cladding material.

25 47. A method of fabricating an integrated optical device as claimed in claim 45 wherein said cladding material comprises an electrooptic chromophore and said poling voltage is applied so as to be sufficient to orient said chromophore along a resulting electric field in said cladding material.

48. A method of fabricating an integrated optical device as claimed in claim 45 wherein an electrically insulative barrier layer is formed over said electrode pattern prior to application of said poling voltage and said cladding material is positioned over said electrically insulating layer.

49. A method of fabricating an integrated optical device as claimed in claim 1 wherein said cladding material defines a thickness at least as large as a thickness defined by said core material layer.

5 50. A method of fabricating an integrated optical device as claimed in claim 1 wherein further portions of said core material layer and said buffer layer are removed to define a pair of contact regions over said electrode pattern.

10 51. A method of fabricating an integrated optical device as claimed in claim 50 wherein said pair of contact regions is treated with hydrofluoric acid to remove residual material from said pair of contact regions.

15 52. A method of fabricating an integrated optical device as claimed in claim 1 wherein portions of said buffer layer are removed to define a core material containment region.

53. A method of fabricating an integrated optical device as claimed in claim 52 wherein said core material containment region is defined prior to formation of said waveguide core material layer over said buffer layer.

20 54. A method of fabricating an integrated optical device as claimed in claim 1 wherein said waveguide core material layer is formed within a core material containment region defined by said buffer layer.

25 55. A method of fabricating an integrated optical device as claimed in claim 54 wherein said waveguide core material layer extends beyond said core material containment region defined by said buffer layer.

56. A method of fabricating an integrated optical device as claimed in claim 54 wherein said waveguide core material layer is substantially confined within said core material containment region defined by said buffer layer.

5 57. A method of fabricating an integrated optical device as claimed in claim 1 wherein portions of said core material layer are removed to define a waveguide core and a pair of cladding containment regions extending along opposite sides of said waveguide core in a direction substantially parallel to a longitudinal dimension of said waveguide core.

10 58. A method of fabricating an integrated optical device as claimed in claim 57 wherein said cladding material is positioned within at least a substantial portion of said pair of cladding containment regions so as to place said cladding material in optical communication with said waveguide core.

15 59. A method of fabricating an integrated optical device, said method comprising:
providing a support wafer defining an electrode support surface;
forming an electrode pattern over said electrode support surface of said support wafer;
forming a buffer layer over said electrode pattern and said support wafer through a sol-
20 gel process characterized by a maximum processing temperature below about 400°C;
forming a waveguide core over said buffer layer; and
positioning a cladding material in optical communication with said waveguide core such
that said buffer layer, said cladding material, and said waveguide core define an optically clad
waveguide core, wherein at least one of said cladding material and said waveguide core are
25 configured such that a control signal applied to said electrode pattern alters a transmission
characteristic of an optical signal propagating along said waveguide core.

60. An integrated optical device comprising:

a support wafer defining an electrode support surface;

an electrode pattern formed over said electrode support surface of said support wafer;

a non-polymeric buffer layer formed on at least a portion of said electrode pattern and

5 over at least a portion of said support wafer;

a waveguide core material layer formed over said buffer layer;

a cladding material in optical communication with said waveguide core such that said
buffer layer, said cladding material, and said waveguide core define an optically-clad waveguide

core, wherein at least one of said cladding material and said waveguide core are configured such

10 that a control signal applied to said electrode pattern alters a transmission characteristic of an
optical signal propagating along said waveguide core.